Day 1 of 4

Science of Nuclear Radiation

Lecture 1

Questions

1. What is the composition of $^{238}_{92}U$?

   a. 238 protons, 146 electrons, and 92 neutrons. It is a nucleon of uranium.

   b. 92 protons, 92 electrons, and 146 neutrons. It is an isotope of uranium.

2. What is the atomic composition of $^{137}55Cs$?

   a. 55 protons, 55 electrons, 82 neutrons. It is an isotope of cesium.

   b. 137 protons, 137 electrons, 82 neutrons. It is an isotope of uranium.

3. Radiological emergency response personnel are called upon to deal with accidents that involve radioactive nuclides or "radionuclides." The nuclei of these atoms contain excessive energy that makes them:

   a. more stable and unlikely to transform into another nuclide.

   b. more unstable and likely to eject alpha or beta particles and energy.

4. When unstable nuclei eject neutrons or protons and release energy, the process is known as

   a. radioactive decay.

   b. ionization.

5. Ionization is an important concept for the radiological emergency responder to understand because:

   a. it is the basis for the biological effect caused by radiation and it provides the evidence that radiation is present.

   b. it describes how protons are removed from the nucleus of an atom, causing biological damage to a cell.

6. An **ion** is any atom that has lost:

   a. a proton.

   b. an electron.

7. If you identified the radionuclides involved in a transportation accident and found that they emit alpha, beta, and gamma radiation, you would conclude that

   a. the radiation presents an internal hazard only.

   b. the radiation presents an external as well as an internal hazard.

8. Your radiation detection instrument indicates the presence of gamma radiation. Gamma radiation _____by protective clothing.

   a. can be stopped

   b. cannot be stopped

9. If a material has a half-life of 1 minute, how long will it take for 100 curies of that material to decay to 25 curies?

   a. one minute.

   b. two minutes.

10. An accident involving a radiopharmaceutical shipment includes chromium-51 (^{51}Cr), which has a half-life of about 27 days. If 800 curies of the ^{51}Cr spilled and were not diminished by any natural effects, at the end of 27 days due to radioactive decay processes.

    a. there would be no ^{51}Cr left

    b. only 400 curies of ^{51}Cr would remain

Day 2 of 4

Nuclear Weapons

Lecture 2

Question

1. Naturally-occurring uranium is mostly ___, whereas the fissile component most useful for nuclear weapons is the ___ form.

   a. U-235, U-238

   b. U-233, U-235

   c. U-238, U-235

2. A 25-kiloton nuclear weapon produces the same amount of energy in an explosion as does ____ tons of TNT.

   a. 25 million

   b. 25 thousand

   c. 2.5 thousand

Day 3 of 4

Effects of Nuclear Detonations

Lecture

Questions

1. In the 1950s, people accidentally contaminated by radioactive fallout from nuclear weapons testing developed beta burns and hair loss. The victims recovered from these effects within approximately six months. These radiation effects would be classified as

   a. early (acute) effects

   b. late (chronic) effects

2. The latent period for acute effects is than that for chronic effects.

   a. shorter

   b. longer

3. Of the five factors that influence radiation damage, the one that takes into account the varying sensitivities of different organs or tissues to radiation is:

   a. the general health of the individual

   b. the portion of the body receiving the dose

4. If you were conducting an assessment of the potential for radiation-induced biological effects of a radiation accident, which of the following could be determined with radiation detection instruments?

   a. biological variability factors

   b. type of radiation

5. If you were exposed to a beta-gamma source such as iodine-131 (I-131), which term would be used to describe the radiation energy absorbed by your body?

   a. roentgen

   b. rad

Name _____

Nuclear Weapons and Radiation Principles
Examination

Multiple Choice

1. Ionizing radiation includes all of the following EXCEPT:
   a. radio waves b. neutrons c. beta particles
   d. alpha particles e. gamma waves

2. Alpha radiation is identified as:
   a. particles the size of electrons, positive charge, low energy
   b. waves of electromagnetic energy
   c. two protons plus two neutrons; positive charge
   d. one pi meson and one neutrino
   e. none of the above

3. Beta radiation is identified as:
   a. particles about the size of electrons, relatively low energy
   b. waves of electromagnetic energy
   c. two protons plus two neutrons; essentially a helium nucleus
   d. one pi meson and one muon
   e. all of the above

4. Neutron radiation:
   a) Is a whole body hazard
   b) Is a skin irritant
   c) causes blindness
   d) does nothing to the body except heats the outer skin

5. Gamma radiation can be extremely destructive to living tissue because:
   a. has a very heavy mass b. the electric charge will shock you
   c. causes beta burns d. gamma radiation is <u>not</u> destructive to tissue
   e. none of the above

6. Interaction of alpha, beta, gamma rays with matter result in:
   a. half-life b. ionization of biological tissue
   c. thermoluminescence d. x-ray production
   e. pseudophosphorescence

7. Significance of ionization to humans:
   a. can result in fission reactions b. may disrupt DNA
   c. linked with cancer and genetic mutations d. causes severe beta burns
   e. b and c only

8. Which of the following is the radiation type capable of traveling the <u>farthest</u> in air?
   a. alpha b. beta c. delta d. gamma e. ions

9. Term for atoms which may have the same number of protons but different numbers of neutrons.
a. fissile b. isotopes c. ionization d. cations e. atomic number

10. A natural source of background radiation:
a. cosmic radiation from deep space b. internal (from the human body itself)
c. radon gas from soil d. building materials (stone)

e. all of the above

11. Nuclear weapons are designed and constructed based on:
a. U-238 b. U-233 c. U-235 d. Pu-239 e. c and d only

12. Half-life may be defined as:
a) The time required for half the atoms of a sample to decay to non-radioactive forms
b) The amount of a victim's lifespan shortened following exposure to radiation
c) A popular video game that was discussed during class
d) The amount of time allowed before a responder can handle radioactive material

13. If an isotope has a half-life of 1 minute, how long will it take for 100 curies of that material to
decay to 25 curies?
a. one minute b. two minutes c. four minutes d. 144 minutes

14. A RDD (radiological dispersal device) is _____?
a) a rifle carried by soldiers
b) a 'dirty bomb' (e.g., explosive attached to a small quantity of radioactive material)
c) thermonuclear device with yields measuring in Mt
d) sophisticated system to remove radiation from structures and equipment
e) none of the above

15. A nuclear configuration which allows for the number of neutrons to increase in succeeding generations.

a. HEU b. LD_{50} c. supercritical mass d. fissile e. Teller Effect

16. Hazard(s) from a thermonuclear explosion:
a. electromagnetic pulse b. thermal (heat) c. shock wave
d. radiation e. all of above

17. The relative distribution of the effects in the previous question depends on:
a. yield of the weapon
b. location of the detonation
c. characteristics of the local environment
d. all of the above

18. The term ___ refers to the increase in atmospheric pressure as the result of a detonation.
a. yield b. mach stem c. overpressure
d. boosted e. thermonuclear

19. Delayed effects of a nuclear detonation that may continue for hours up to years.
a. overpressure b. electromagnetic pulse c. fallout
d. deuterium and tritium e. prompt radiation

21. The ___ occurs because of attack on a molecule by ionizing radiation followed by the destruction of the molecule.
a. Compton scatter mechanism b. indirect action mechanism
c. direct action mechanism d. The Curly Howard Effect

True-False

22. Alpha radiation can be stopped by a layer of dead skin. It is therefore not an external hazard to humans. FALSE

23 The approximately 25 (and growing) number of elements that are 'man-made' are known as 'transuranic' because they are heavier than uranium. TRUE

24. Large quantities of U-238 exist in nature; however, U-238 does not readily undergo fission. TRUE

25. Gamma rays have no mass and no charge; they are electromagnetic energy. TRUE

26. An unstable atom will attempt to reach stability by ejecting alpha or beta particles and/or releasing energy in the form of gamma radiation. This process is known as radioactive decay, or "radioactivity." TRUE

27. The process of removing an electron, leaving charged particles (the atom with a net positive charge), is "radioimmunosorption". FALSE

28. Beta burns may develop hours after the start of the exposure. TRUE

29. The key players in the Cold War were the Soviet Union (USSR) and Germany. FALSE

30. The yield of an explosive is typically expressed in terms of the quantity of TNT. TRUE

31. Implosion-type weapons require less fissile material than gun-type weapons. TRUE

32. An electromagnetic pulse from a nuclear detonation can erase computer memories and stop the functioning of electronic devices. TRUE

33. Time, distance and shielding are essential components of protection from nuclear radiation.
TRUE

34. The largest nuclear weapon ever detonated was constructed by the Soviet Union (USSR).

TRUE
35. The human body is constantly being exposed to small amounts of radiation from natural sources. TRUE

36. If a human is exposed to 1 REM of radiation, even if over many years, their risk of cancer is increased by 50% or more. FALSE